I. The Instant Invention

The instant invention relates to sensor arrays that are able to mimic chemical sensing, *i.e.* electronic noses. These sensors are applicable to a wide variety of applications, including environmental and quality control, biomedicine, emissions control, gas detection, illegal substance detection, infectious disease detection, etc. Advantageously, the sensors of the present invention enhance the signal-to-noise ratio (S/N) of the sensor element. By increasing the S/N of a sensor element, a lower detection limit is possible (*i.e.*, the lower the concentration of analyte it is possible to detect).

The present invention provides a sensor having an aligned conductive region that results in a reduced percolation threshold. Reduced percolation thresholds mean that a slight swelling of the composite sensor can result in a very large change, in for example, the resistance. In a preferred embodiment, the aligned conductive region produces a stable base resistance and thereby enhances the signal-to-noise ratio while maintaining low volume loadings.

II. Rejection under 35 U.S.C. § 102(b) in view of Debe *et al.*

The Examiner has rejected claims 1-7, 9-15, 17 and 29-31 under 35 U.S.C. § 102(b) as allegedly being anticipated by Debe *et al.* (U.S. Patent No. 5,238,729). In response, Applicants respectfully traverse the rejection.

The Examiner alleges that Debe *et al.* discloses the instant invention at column 12, lines 34-45 and column 23, lines 1-25, "where two sensors, having aligned conductive regions 16, see Fig. 1, comprise an array." Applicants respectfully disagree. Debe *et al.* teaches an array of whisker-like structures in combination with a conformal material to yield microstructures that are normal to the substrate surface, and are parallel to one another, column 8, lines 24-29:

> Typically, the orientation of the whisker-like structures is uniformly related to the substrate surface. The structures are preferably oriented normal to the substrate surface, that is, perpendicular to the substrate surface. Preferably, the major axes of the whisker-like structures are parallel to one another.

In this description, Debe *et al.* is describing the physical and macroscopic orientation of the whisker-like structures in relation to the substrate and one another, without any reference or teaching as to the orientation or alignment of the discrete components (atoms, molecules, nanoparticles, etc.) that comprise the whisker-like structures or conformal coating.

In stark contrast to the teaching of Debe *et al.*, the present invention claims a sensor array wherein the individual sensors are comprised of aligned conductive material, wherein the alignment of the conductive material refers to the alignment of the discrete components (atoms, molecules, nanoparticles, etc.) that comprise the conductive material. Alignment, as used in the instant invention, does **not** refer to the physical macroscopic orientation of the individual conductive materials, but rather to the electrical, thermal, magnetic, electromagnetic, photoelectric, mechanical, etc., alignment of the discrete atoms, molecules, nanoparticles, and the like, that make-up the conductive material as a whole. In this regard, the Examiner's attention is respectfully directed to page 6, lines 3-10 of the specification:

> The sensors of the present invention have an aligned conductive region that results in reduced percolation thresholds. Reduced percolation thresholds mean that a slight swelling of the composite sensor can result is[*sic*] a very large change in resistance. This is because the few conductive particles are all participating in the connected paths, and any discontinuity in the connectivity results in a large resistance change. Thus, *the alignment of the conductive region results in all of the particles participating in the connected electrical paths. By aligning the conductive region, these systems will produce a stable base resistance and thereby enhance the signal-to-noise ratio.* (Emphasis added).

In addition, the appropriate methods for carrying out the alignment of the conductive material are set forth at page 6, lines 15-21:

> The alignment of the conductive region, *e.g.*, material or particles, is effected through the application of various processing techniques. For instance, polarization techniques can be used to align the conducting region. Suitable polarization techniques include, but are not limited to, exposure to an electric field, a thermal field, a magnetic field, an electromagnetic field, a photoelectric field, a light field, a mechanical field or combinations thereof. The techniques employed to align the particles depends in part on the particle composition.

There is no discussion whatsoever in Debe *et al.* about how to "align" the discrete components of the whisker-like structures or of the conformal coatings. There is only a discussion about the

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preferred macroscopic physical orientation of the whisker-like structures to the substrate and to one another.

As the Examiner is aware, the cited reference must teach every element of the claim, MPEP § 2131:

> "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." Verdegaal Bros. v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

The alignment of the discrete components of the conductive material is an important feature of the instant invention, which is not taught or suggested in the prior art. The Examiner's attention is respectfully directed to page 5, lines 7-10 of the current specification:

> Surprisingly, it has now been discovered that by intentionally aligning the conductive region, there is an increase in the detection limit, *i.e.*, the sensor is capable of detecting lower concentrations of analyte;

and page 5, line 31 to page 6, line 2:

> Before the advent of the present invention, the noise level associated with such low volume loadings was prohibitively high. However, by aligning the conductive region, lower volume loadings can now be used. Moreover, by aligning the conductive region, the percolation threshold is easier to obtain at low volume loadings.

In addition, Example 1 of the present invention, demonstrates the lower percolation threshold when using an aligned conductive material, see Figures 1 and 2. Figure 2 shows the resistance versus volume curve using an aligned conductive material. This material demonstrates a 75% decrease in the percolation threshold compared to the non-aligned conductive material shown in Figure 1.

Applicants submit that Debe *et al.* fails to disclose not only the alignment of the discrete components of the conductive material as taught and instantly claimed, but also the importance of such an innovation. Moreover, the relationship of aligned conductive materials to improved signal-to-noise ratios in not taught or suggested in the cited art. Accordingly, Debe *et al.* fails to teach every element of the instant invention, and thus does not anticipate the claims of the instant application.

In view of the above, Applicants submit that the Examiner has inappropriately applied the use of the term "align", as it relates to the instant application, to Debe *et al.* As used in the instant application, "align" refers to the electrical, thermal, magnetic, electromagnetic, photoelectric, mechanical, etc., alignment of the discrete atoms, molecules, nanoparticles, etc., that make-up the conductive material as a whole. In contrast, Debe *et al.* teaches only the physical macroscopic orientation of the whisker-like structures in relation to the substrate and to one another. In addition, Debe *et al.* fails to teach an aligned conductive material as is taught and claimed in the instant application. As such, Applicants submit that Debe *et al.* fails to disclose the claimed invention. Accordingly, Applicants respectfully request that the rejection be withdrawn.

III. Rejection under 35 U.S.C. § 103(a) in view of Debe *et al.* in combination with Lewis *et al.*

The Examiner has rejected claims 8 and 16 under 35 U.S.C. § 103(a) as allegedly being obvious in view of Debe *et al.* in combination with Lewis *et al.* (WO 99/00663). In response, Applicants respectfully traverse the rejection.

The Examiner alleges that "the claimed invention is disclosed as noted above except the particular metal oxides." Applicants respectfully disagree. As discussed above in Section II, Debe *et al.* fails to teach an important feature of the instant invention: the alignment of the discrete components of the conductive material. Debe *et al.* describes and teaches in detail the physical macroscopic orientation of the whisker-like structures, as well as the method of making the whisker-like structures via chemical vapor deposition (see Example 1 of Debe *et al.*) However, Debe *et al.* fails to teach a method of preparing the whisker-like structures via externally applied forces. In contrast, the instant application teaches and claims the methods for aligning the components comprising the conductive material via externally applied forces such as electrical, thermal, magnetic, electromagnetic, photoelectric, mechanical, etc.

In addition, Debe *et al.* is silent in regard to the orientation of the materials that comprise the whisker-like structures and conformal coatings. There is also no discussion in Debe *et al.* regarding the importance of aligned conductive materials to obtaining improved

signal-to-noise ratios at low volume loadings. Furthermore, Lewis *et al.* teaches only a combinatorial approach for preparing arrays of chemically sensitive polymer-based sensors for the detection of analytes in a fluid. Accordingly, Applicants state that there is simply no motivation or suggestion provided in the cited references to modify their teachings in the way the Examiner has contemplated. Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992).

As there is no suggestion or motivation in Debe *et al.* or Lewis *et al.* to align the discrete components of the conductive material, Applicants submit that it would not have been obvious to start with the inventions of Debe *et al.* and Lewis *et al.*, and arrive at the present invention. Accordingly, Applicants respectfully request that the rejection be withdrawn.

IV. CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 925-472-5000.

Respectfully submitted,

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APPENDIX A: PENDING CLAIMS

1. (Twice Amended) A sensor array for detecting an analyte in a fluid, said sensor array comprising: first and second sensors wherein said first sensor comprises a sensing region of an aligned conductive material and a nonconductive region, each of which sensors provides a different detected response in the presence of said analyte; wherein said sensor array is electrically connected to a computer comprising a resident algorithm; the computer detecting said response and comparing said response to a known sensor array response profile.

2. The sensor array for detecting an analyte in a fluid in accordance with claim 1, wherein said first and said second sensors are first and second chemically sensitive resistors, each of the chemically sensitive resistors comprising: a plurality of alternating regions comprising a nonconductive region and an aligned conductive region that is compositionally different than the nonconductive region, wherein each resistor provides an electrical path through said nonconductive region and the aligned conductive region; a first electrical resistance when contacted with a first fluid comprising an analyte at a first concentration; and a second electrical resistance when contacted with a second fluid comprising said analyte at a second different concentration.

3. The sensor array for detecting an analyte in a fluid in accordance with claim 1, wherein said conductive region is aligned by exposure to a member selected from the group consisting of an electric field, a thermal field, a magnetic field, an electromagnetic field, a photoelectric field, a light field, a mechanical field, and combinations thereof.

4. The sensor array for detecting an analyte in a fluid in accordance with claim 3, wherein said conductive region is electrically aligned.

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5. The sensor array for detecting an analyte in a fluid in accordance with claim 3, wherein said conductive region is magnetically aligned.

6. The sensor array for detecting an analyte in a fluid in accordance with claim 3, wherein said conductive region is photolytically aligned.

7. The sensor array for detecting an analyte in a fluid in accordance with claim 1, wherein said aligned conductive material is a member selected from the group consisting of metal, magnetic alloys, ceramics, oxides, intermetallic compounds, carbon black, nanoparticles and composite materials.

8. The sensor array for detecting an analyte in a fluid in accordance with claim 7, wherein said conductive material comprises carbon black.

9. The sensor array for detecting an analyte in a fluid in accordance with claim 7, wherein said conductive material comprises a nanoparticle.

10. The sensor array for detecting an analyte in a fluid in accordance with claim 7, wherein said conductive material comprises a metal.

11. The sensor array for detecting an analyte in a fluid in accordance with claim 10, wherein said metal is a member selected from the group consisting of nickel, cobalt, iron, a ferrite and their magnetic alloys.

12. The sensor array for detecting an analyte in a fluid in accordance with claim 10, wherein said metal is a coating of a substrate, said substrate is a member selected from group consisting of glass, silicon, quartz, ceramic or combination thereof.

13. The sensor array for detecting an analyte in a fluid in accordance with claim 10, wherein said metal is a member selected from the group consisting of a precious metal coating and precious metal alloys.

14. The sensor array for detecting an analyte in a fluid in accordance with claim 13, wherein said precious metal coating is a member selected from the group consisting of silver, gold and platinum.

15. The sensor array for detecting an analyte in a fluid in accordance with claim 7, wherein said conductive region is an oxide.

16. The sensor array for detecting an analyte in a fluid in accordance with claim 15, wherein said conductive region is a member selected from the group consisting of In_2O_3, SnO_2, $Na_xPt_3O_4$, TiO_2 and $BaTiO_3$.

17. The sensor array for detecting an analyte in a fluid in accordance with claim 1, wherein said aligned region is a material selected from the group consisting of copper phthalocyanine and phenothiazine.

29. (Amended) A sensor array for detecting an analyte in a fluid, said sensor array comprising: first and second sensors wherein said first sensor comprises a sensing region of an aligned conductive magnetic material and a nonconductive insulating region, each of which sensors provides a different detected response in the presence of said analyte; wherein said sensor array is electrically connected to a computer comprising a resident algorithm; the computer detecting said response and comparing said response to a known sensor array response profile.

30. The sensor array for detecting an analyte in a fluid in accordance with claim 29, wherein said aligned conductive magnetic material comprises iron.

31. The sensor array for detecting an analyte in a fluid in accordance with claim 29, wherein said nonconductive insulating region is a polymer.